



Materials Engineering Branch

TIP*



No. 040 Vacuum Outgassing of Organic Materials

Author(s): A. J. Babecki and E. W. Mielke

Contact: (301) 286-6882

One of the main concerns of spacecraft technologists is that of the possibility of contamination of critical surfaces which may degrade their performance or cause them to fail their function altogether. Optical elements that become coated with organic films undoubtedly will lose transmission capability. Cooled detectors, which become covered with condensed molecules, even moisture, can be rendered useless. Thermal control surfaces will gradually change their absorption and emission characteristics if covered with contaminants, especially if these contaminants have been exposed to ultra-violet radiation that has effected changes in them, such as polymerization.

To minimize such contamination, the aim is to select organic materials for flight hardware and test chambers that will not serve as sources of contamination. About forty years ago, the Stanford Research Institute (SRI), working for the Jet Propulsion Laboratory, established a test technique to measure a material's outgassing behavior in vacuum. Since that time, other NASA Centers including GSFC, commercial companies, and European space organizations have adopted and improved the technique to test materials for vacuum and space use.

In brief, this technique employs a small sample of the test material in question, preconditions it at 50% RH for at least 24 hours, exposes it to high vacuum (10^{-6} torr or greater) at 125°C for 24 hours and reconditions it at 50% RH for 24 hours. The mass of the sample is determined before and after these steps as well as the mass of the condensed material that is captured on a condensing disk controlled at 25°C in close proximity to the sample chamber aperture.

The results are presented as Total Mass Loss (TML) percentage and as Collected Volatile Condensable Materials (CVCN) percentage. Maximum allowable values for these parameters, that were specified by SRI, are 1.0% TML and 0.1% CVCN. The American Society for Testing and Materials has accepted this procedure as ASTM E-595-93, "Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment". Although many of the materials on board the

spacecraft will never experience temperatures as high as the 125°C employed in the test and, therefore, would not have the same outgassing rate, they will be exposed to vacuum for much longer periods of time and still may outgas as much over the mission life. Therefore, the philosophy of GSFC is to recommend the test as a screening method to select those materials that will have low outgassing. Thousands of organic materials have been tested by this technique, and the results are compiled in the following website and NASA documents:

<http://outgassing.nasa.gov>

NASA Reference Publication 1124 (Rev. 4), "Outgassing Data for Selecting Spacecraft Materials," June 1997, Goddard Space Flight Center, Greenbelt, MD 20771.

JSC 08962, "Compilation of VCM Data of Non-Metallic Materials," Rev. P, March 1978, available from McDonnell Douglas Technical Services Co., Houston Astronautics Division, Dept. E902, 16915 El Camino Real, Suite 220, Houston, TX, 77058, Attn: M. L. McKee.¹

MSFC-HDBK-527 (latest revision) "Materials Selection Guide for MSFC Spacelab Payloads"¹

When using these documents, care should be taken to select only those organics that pass the test with the formulation and cure stated. The same materials with different formulations and/or cures may not pass the test.

¹ These two documents have been replaced by on-line MAPTIS versions that should be available once MSFC completes institution of enhanced Internet security measures. Persons should contact MSFC to set up an account.